Excerpts from Wired to the Electronics Cluster
Two Community Colleges in Silicon Valley

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I. Introduction

California's Silicon Valley is the nation's quintessential, and widely acknowledged benchmark, cluster. With scale, specialized expertise, experienced workers, social capital and networking, and entrepreneurial energy, it virtually defines the term "cluster." About 6,000 electronics and software companies, including 20 percent of the world's largest companies in those two sectors, are packed into the narrow corridor from Palo Alto to Santa Cruz. Santa Clara County alone has more than 4,000 of these firms.

This intricately integrated high-tech region requires an enormous scope of talented, specialized human resources to keep it fueled, and a high quality education and training establishment, much of which is provided by its universities, to replenish and refresh it. But while the engineers and computer wizards from Stanford have become Silicon Valley's icons, the highly skilled production workers and technicians have generated the profit from their ideas. According to Apple founder Steve Jobs, we "realize that all the innovation comes from them [the employees]... they really [lay] the foundation and...[provide] the shoulders that we all [stand] upon after them."[1] Silicon Valley's educated work force has become acquainted with the industry through a different set of institutions which have received far less attention and credit than the research universities: the Valley's eight public community colleges and many private schools and training institutes.

Deep in the heart of the Valley, De Anza Community College has been named the most wired college in the United States, which is no surprise given its location. Using its connections to the industry and technology of the industry, it turns immigrants looking for jobs, professionals looking for new opportunities and skills, and young people looking for careers into a technical work force. Just a few miles away, Mission Community College, the nation's third most wired community college with a predominantly minority student body, is tightly linked to the semiconductor industry.

But they can't produce skilled workers fast enough. With unemployment now at only about three percent, the supply of technical talent is at a premium. An Intel manager

predicted at an opening of a new community college training lab for chip makers that the semiconductor industry will have "an appetite for as many as 40,000 new technicians over the next five years."[2] According to a local college administrator, "a good technician is now worth his weight in gold." Many companies simply cannot find people with the necessary skills, forcing them to recruit from outside the region or consider moving production elsewhere.

The two colleges chosen for this study represent the area's many community colleges in the cluster. The largest pre-baccalaureate education institution and the largest community college campus in the west is De Anza Community College. Mission Community College is a smaller but innovative postsecondary institution that complements De Anza. De Anza, as host to both a new Advanced Technology Center and a Center for Applied Competitive Technologies, and Mission Community College (and about to build a new technology center), through its close ties to the semiconductor industry, offer excellent examples of how colleges respond to, affect, and interact with the electronics and software industries and where they fit into the high-tech complex industry cluster called "Silicon Valley" and its education and training enterprise.

Joint Venture: Silicon Valley: Nurtured by numerous associations and clubs, the collaboration and cooperation that sustains the cluster was recently further legitimated by the formation of a large scale regional initiative called Joint Venture: Silicon Valley. Incorporated in 1993, its vision is "a community collaborating to compete globally." Its programs aim to stimulate innovation, exports, and an entrepreneurial spirit in the context of a "networked economy." Joint Venture tracks the progress of the region and compares it to its U.S. competitor high-tech regions, such as Austin, Texas; Research Triangle Park, North Carolina; Boston, Massachusetts; and Seattle, Washington.

The region also realizes the importance of the work force and shares with other regions in the U.S. the same concerns about education, but given the highly skilled nature of the work, they are perhaps even more pressing here. Thus, the target of many of the earliest initiatives was public education. In 1994, the organization launched Challenge 2000, which assembled educators, school board members and business executives from two thirds of the Valley's school districts to choose "Renaissance Teams" of schools that would work together to improve education. In 1996, Joint Ventures introduced SmartSchools and with 8,000 volunteers, connected more than 100 schools to the internet. In 1997, it started the 21st Century Education Initiative, a typically Silicon Valley venture capital model, with investments in education in which the payback is improved student performance. Groups of schools lose their funding, however, if they fail to meet their goals. One group of schools, for

example, targeted improved literacy and another improvements in math and science achievements.

The Valley's Work Force: Twenty years ago, labor economists criticized the semiconductor industry for using low-wage labor in repetitive semi-skilled work to manufacture high-tech products.[3] While there are certainly still large numbers of low-wage jobs in Silicon Valley, automation and the realignment of the industry away from mainly semiconductors to higher value-added software and integrated circuits (which now comprise 40 percent of the internal components of a personal computer) has raised the educational requirements and pay scales significantly. In 1996 real wages grew by more than five percent in the Valley, compared to one percent for the entire U.S. A continuing criticism, however, is that a large number of jobs are held by temporary employees with no benefits. Employment contracted through temp agencies grew from 17,000 in 1992 to more than 36,000 in 1996,.[4] and the first jobs of about 30 percent of all school leavers' are temporary.

Whether contract or permanent, forty percent of the jobs in Santa Clara County's cluster companies' now are professional, paraprofessional, or technical. Behind the dynamism of the economy, the glamorization of "computer nerds," and the 62 new millionaires reportedly made per day, is a very large technical and skilled work force that threatens to be a weak link in the value-added chain. Intel predicts a shortfall of 20,000 technicians in the next four years. Cisco Systems has gone so far as to rent advertising space in billboards to find the new employees it needs.

With 41 institutions of higher education in the region, it is easy to lose sight of which institutions offer what services, and which perform most effectively. In this vast array and amidst the dominance of Stanford, it is not too surprising that the contributions of the region's community colleges are often understated, if not omitted altogether in the popular reports. Yet their education and training programs, business and industry centers, economic development institutes, and technology centers are very much a part of the infrastructure that supports the electronics and software cluster.

The Big Players: There are many large companies serving as the engines of growth for the smaller companies and wellsprings of entrepreneurial talent—Cisco, Apple, Sun Systems, Intel, and National Semiconductor, among others. While linked to the universities, as production technologies become more sophisticated, they become increasingly dependent on the community colleges.

Intel is a good example of these tightening ties. In need of more technically competent technicians, they looked at 15 community colleges in the region, ranked them on their ability to deliver a national semiconductor technician associate degree

program, and selected the top two colleges, which turned out to be Mission and San Jose City Community Colleges. In this process, according to the human resources director at Intel, they were not in search of narrowly trained technicians, rather well-rounded employees who understand scientific concepts and the industry in addition to the process. Therefore, they not only want graduates to take a broad range of courses, but Intel also wants to influence the content of these courses. For example, a chemistry class might address issues of toxicology in the industry, and an English class might teach technical writing. Intel makes a significant investment in this program in hopes of hiring about 25-30 percent of a graduating class. The company has also made a commitment to encourage students to complete their associate degree program even though it is tempting to leave for the many good jobs available after acquiring a portion of the skills. Intel may offer a student a position before completion but strongly encourage, and even pay for, continued enrollment towards the degree.

De Anza Community College

De Anza is one half of the Foothill-De Anza Community College District. Foothill Community College was one of California's original "junior colleges," established forty years ago as an alternative path for the first two years to a baccalaureate degree. Ten years later, on a site purchased by the district for future expansion in nearby Cupertino, the Foothill college district built De Anza, named after a Spanish explorer who camped near the site in 1776. By 1967, California's community colleges were becoming more vocational in response to the emerging business and industry needs for employees with more than a high school education, but less than a university degree.

De Anza opened its doors to 5,600 students with 188 full-time faculty and administrators. But De Anza's founding president, Robert DeHart, believed that a community college need not be limited by its walls, and the college went into the community and company to offer courses on site. By the early 1970s, the college had shifted much of its attention from the 13th and 14th years of education for youth to work force preparation.

Today, it serves 26,000 students and employs 573 full-time faculty and administrators in an attractive, 112 acre campus with Spanish style architecture and courtyards complete with large outdoor sculptures. More than 60 percent of the students come from outside of the district, a market indicator of the college's reputation. In fact, the school has developed a national reputation for excellence.

Just last year De Anza opened its new 66,000 square foot, three-story, Spanish style Advanced Technology Center (ATC). This new facility added sufficient computer capacity, warranting *Yahoo!* magazine in May 1997 to name De Anza the "most wired" college in the nation (i.e., the most exposure to and use of the internet). The ATC alone, wired for 1,200 computer work stations, already has nearly 700 in operation with 6 Novell and 3 Unix servers. Although the state of California provided the $13 million to build the Center from bonds, it only appropriated half the $6 million necessary to fully equip it. To acquire the difference, the college went to local electronics and software firms and the National Science Foundation, which have made up most of the difference. Apple, for example, did much of the wiring of the facility. By mid-1997, the ATC had a staff of 104 to serve the approximately 12,000 students who use it daily. In addition, companies (e.g., Sun Microsystems and Silicon Graphics) send employees to the ATC for workshops to periodically learn about new industry trends.

The three stories of the ATC facility are each designed to serve a family of computer-based education programs: (a) computer systems and applications, (b) production technologies and sciences, and (c) technical arts. On the middle (ground) level, the business computer/systems lab has 320 work stations for individualized instruction which are mostly occupied at mid-morning by students learning local industry skills, such as "C" language and UNIX systems, or acquiring other technical competencies. Tutors and instructors rove the aisles to answer questions and help solve individual problems. The upper level of the ATC houses labs for math and statistics, applied physics, surface mount technology, design drafting, CIM, CAD, and CAM. The lower level is dedicated to computer-based graphic design, writing, film/TV, animation, and language.

In the new environment, according to the dean, business and industry must drive changes. This is sometimes difficult for traditional educators to accept. Two years ago, De Anza administration decided to drop an electronics technology program because tenured staff refused to accept the industry board's suggestions for change.

Programs for the Industry

Although De Anza has no explicit electronics technology programs (e.g., process technician, mask design technician, or equipment technician), the college responds to the needs of the industry through its many computer based programs, Manufacturing and Design Technology (MDT), and Computer Information Systems (CIS) programs, all of which are offered for certificates and associate of applied science degrees. The

MDT lab appears to be a traditional advanced manufacturing technology with conventional machine tools, CNC machines, robots, and CIM training and CAD/CAM work stations. Its relevance to the cluster is through the context in which the training occurs—industry-specific problems are presented to students, often by faculty from the industry or by students themselves (60 percent of whom work or have worked in the electronics industry and about 25 percent of whom are in biosciences, a heavily electronic field), and through special industry-specific courses such as surface mount technology. Special associate degrees are available in model building and product prototype, experimental machinist, and systems technicians. The four main programs have an industry advisory board that helps the staff decide just what to teach and what equipment to purchase. This year, as they do every three years, the boards will complete a detailed 600-question survey about skill sets required in the workplace so that faculty can match the curriculum and content to industry needs.

To allow students flexibility and speed the flow of students into industry, the program offers an accelerated version where students can double their workload and complete an associate degree in just one year. A sign of the good times in the valley, however, is that many of the students enroll just to acquire enough skills to get employed. Businesses pull students as quickly as they can meet their basic requirements. Most evening students enroll to aquire skills rather than degrees; many already have advanced degrees. In the CAD program, 40 percent of those enrolled have four-year degrees, and in the manufacturing program about 15 percent have degrees. It is more common for day time students to complete degrees.

Despite the high demand, the college has to work hard to recruit top flight young students. Manufacturing, even in the high tech environment of Silicon Valley, has a poor image. One high school counselor told the director "you won't get our kids here because their parents won't allow them to come." The program is much better more appealing to those who are already in the labor force.

The computer information systems program is applicable to any industry, but customized through the context and the experiences of the students. One of the most popular programs is ProE (proEngineering), whereby students learn multidimensional electronic drafting, a skill which is increasing in demand as the industry automates. The program is currently oversubscribed, with about 20 to 30 on the waiting list for the evening course. The instructor lists four kinds of students—those who: (1) are in the field and want to upgrade their skills, (2) are just out of high school and want vocational skills, (3) are preparing for four year degree, or (4) want new skills to help change careers. But in this program, out of 1,000 students, only about five percent will actually complete an associate degree.

Surface mount technology (SMT) is another popular industry program offered, although not every semester, in a laboratory on the third floor of the ATC (see Table 1). SMT combines lecture and lab and requires team projects and collaborative presentations to the rest of the class. Examples of a few of the programs and specific courses related to and in demand by the industry and their enrollment patterns are shown in Table 1. De Anza, with its new advanced technology center, is building its strength in the computer sciences. The manufacturing courses remain under-enrolled, in part because the demand is so high that companies hire quickly and only use the colleges for specific skills they cannot provide. Paradoxically, enrollments go up when industry demand is weak, not vice versa.

De Anza Community College's Center for Applied Competitive Technologies

The California legislature in 1989 authorized the community college to establish eight regional satellite centers for applied competitive technologies (CACTs). As a result of their regional expertise, four colleges won the original competition, including De Anza which was able to demonstrate competence in the semiconductor and electronics industries. The centers' service area extends from Santa Cruz through Mendocino counties in northern California. The mission of these centers was similar to those of the manufacturing extension partnership (which did not yet exist): to help small and mid-sized manufacturing enterprises (SMEs) stay competitive. At the start, the CACTs followed the lead of many community colleges and set up sophisticated computer-integrated manufacturing (CIM) cells to demonstrate and teach advanced methods to industry. As experienced by most other advanced technology centers, these centers found little demand in the Valley or elsewhere in northern California. De Anza's CATC then turned to their SME customers to identify their most pressing needs. They turned out to be workshops, customized training, needs assessments, technology transfer, and technical assistance. CACT is governed by a ten-person industry board that meets semi-annually and additionally, as needed. The CACT director meets with other CACT directors quarterly to map out strategies.

To meet the diverse needs of SMEs in this dense cluster, Paulette Young, De Anza's CACT director, has emulated the networking of industry in the Valley and formed a variety of affiliations, networks, and alliances. For example, in the area of technology transfer the Center affiliates with the NASA Regional Technology Transfer Centers and the University of Southern California's technology transfer center; has a "memo of understanding" with Lawrence Livermore National Labs; and has a cooperative agreement with Sandia National Labs. The CACT also is an affiliate of the Electronic Manufacturing Productivity Center in Indianapolis, Indiana, has worked with (and contributed required state match of federal funds to) the California Manufacturing

Technology Center, and is a member of the National Coalition of Advanced Technology Centers.

The CACT offers about 30 workshops per year in areas such as design of experiments, geometric dimensioning and tolerancing, statistical process control, introduction to ISO 9000, and surface mount technology. Companies pay on a per person basis for a one to two-day program. With a lean staff, the CACT relies on networks of consultants and college staff who have the appropriate industry experience to do much of the actual training and work. Its customized training included a recent course for three different groups of engineers at Hewlett Packard who needed to know basic machining fundamentals so they could respond to problems when they could not afford to wait for a certified machinist.

Business & Industry Institute

The two colleges comprising the Foothill-De Anza community college district operate a Business & Industry Institute that performs contract and customized education and training for industry. This office was the first business training institute in California's community college system and became a model for other colleges. It perforks skills assessments and offers both credit courses and non-credit skills upgrading, either at the college or at the company site using either college instructors and industry consultants. Offerings in 1997 include courses in International Business (e.g., Doing business in Korea, Japanese Business Culture), computer science (e.g., C++ language, Java, Unix programming). Manufacturing (e.g., ISO, Preparation for APICS certification), Internet (e.g., HTML scripting); and General Training (e.g., Electronics Technician, Soldering, and Data Communications).

In addition to learning directly from its industry associations, the college district conducts economic research to inform its programs. In 1996, it produced "Business Today/Business Tomorrow: A Report of the Northern Santa Clara Business Retention and Economic Development Project,"[5] which analyzed the economy's strengths and weaknesses, service needs, and work force needs. It found, for example, that the greatest demand would be for computer-related occupations (38 percent of businesses) and that the educational improvement most likely to strengthen the cluster was in computer skills (41 percent). Improving engineering and technical, skills, however, rated lower than business skills and basic skills as a means to bolster the cluster.

Mission Community College: Focusing on the Semiconductor Industry

Only a few miles from De Anza, another relatively new community college is building connections to the cluster. Just as De Anza spun out of Foothill Community College, Mission Community College was given birth to by West Valley Community College 20 years ago—the result of a revolt by faculty wanting a stronger vocational agenda and closer ties to industry in lieu of the more rigid, academically oriented program of West Valley Community College. The college has grown from its initial interim campus in a remodeled grammar school to its present 164-acre campus in Santa Clara. The college has 10,000 students enrolled (about 6,000 full-time equivalents), many of them adults pursuing a variety of short-term and long-term educational objectives. More than one third are over 35 years of age and 70 percent are minority (38 percent Asian or Filipino). The busiest time of day at the college, according to staff, is 4 pm to 7 pm, when 55 percent of the student body attends classes.

Although the college offers a wide range of programs, the effects of the area's dominant industries are pervasive. Associate in science degree programs at Mission include semiconductor manufacturing technology, computer information systems, and design drafting/electronics, plus computer/electronics and engineering which can be transferred to universities. The college also offers its full associate degree programs for electronics technicians on site at Intel and National Semiconductor, and makes full use of the cluster's resident technologies. *Yahoo!* magazine named Mission the third most wired college in the nation (De Anza was first).

The college's work with industrial partners such as Intel, National Semiconductor, and Sun Microsystems (whose CEO is a graduate of Mission), clearly drives the programs and influences content and context. Two years ago Intel set out to identify the colleges best able to deliver the advanced education for semiconductor technicians that had been developed by Sematech, and they selected Mission and San Jose State Community Colleges. (De Anza also was considered but was then in the process of administrative changes and eliminated its electronics programs for reasons previously mentioned.)

Much of the credit for this can be attributed to the vision of Mission's then new president, Dr. Michael Rao. He took the post in 1994 with the goal of enhancing the college's ability to serve, and its reputation among, Silicon Valley's high-tech industries, much of which are electronics. From the start, one of the cluster's greatest unmet needs was for mask design in the semiconductor industry—a position that started technicians at more than $35,000. Intel alone projects hiring 4,000 electronics technicians in the next two to five years.

With a small development grant from the state, Rao brought together industry leaders, including Cypress, AMD, National Semiconductor, and Intel, to develop replicable

programs to support the growth needs of this part of the semiconductor industry (e.g., mask design, facilities, manufacturing, and sort/test technicians). The technologies in this field were rapidly changing, and companies needed employees with solid competencies in chemistry, math, physics, English, and intercultural skills, in addition to the technical skills. The companies were skeptical at first of a community college's ability to fill positions for which they had previously depended on university graduates, but agreed to work together to develop the programs. Mission's president raised about $700,000 for new high-tech equipment (including grants of $125,000 from Applied Materials, a large equipment manufacturer, and $125,000 from Kinetics, which designs and builds and clean rooms). In addition, the college earns about $3 million per year by renting 60 acres of the 164-acre college site to businesses. The college now offers both certificates and associate of science degrees in computer electronics technology, design drafting with an option in electronics, semiconductor manufacturing technology, and engineering.

Just as industry was leery of the ability of the college and the technical skills of its faculty, the faculty, too, were at first skeptical—of whether industry would insist on controlling the curriculum and methods. Much of the distrust was overcome by arranging for faculty to become much more familiar with the industry. Intel and the college set up a summer internship program where faculty members are paired and work side by side with technicians (and paid about $35 per hour) in the companies' fabrication plants to learn about the production processes. This extends not just to vocational faculty but to all disciplines, e.g., Chemistry, English, and Philosophy. Each faculty member has a deliverable at the end of the summer, such as a report, new curriculum, or instructional process. This enables faculty to better integrate some of the core knowledge of the industry and make the course content more relevant to the many students (80 percent of students work) drawn from the industry. For example, when the college teaches math—from basic through differential equations and linear algebra—the context remains practical, drawing on examples from industry applications like statistical process or inventory control.

One result of these close ties to industry which address skills shortages is that fewer and fewer students are completing programs. According to one faculty member, "industry says give me this skill, this skill, and this skill, but nothing else." Industry draws them away as quickly as they acquire the specific skills required. Another issue has arisen as the result of students with engineering degrees returning and mixing with younger, less educated students. The engineers want to understand underlying theory and the others just want to be able to apply methods.

Mission Community College's Corporate Training

The most direct links between the college and industry are facilitated through the West Valley-Mission Community College District's Economic Development Institute (EDI). Its corporate training, established in 1989, is similar to other states' customized training, but is primarily aimed at existing (generally very large) industries rather than recruiting new businesses. It provides specific skills training, management courses in team building, leadership, and communications, and language skills for the large immigrant work force. In 1996, Corporate Training enrolled nearly 3,000 students in 130 classes.

As the EDI has matured, it has become the host organization for other related business services, such as the Small Business Development Center (SBDC) which assists small companies, provides loans, and trains entrepreneurs; the California Procurement Training & Assistance Center (CalPTAC) which teaches companies how to work with government agencies; Alternative Transportation Solutions (ALTRANS) which addresses traffic congestion problems by minimizing student commutes; and Community Education. The college's corporate training staff remains tightly connected to the electronics industry through informal networking that takes place at business association and professional functions of corporate management, (e.g., the Human Resource and Management Association). The SBDC at the college awarded $6.5 million in loans last year, CalPTAC helped acquire $7.5 million in contracts, and ALTRANS eliminated 2,255 trips by students.

The EDI also offers certificates, associate degrees, and university articulation on site at various companies through its "corporate college" program because, staff contend, "more and more of the large companies are requiring at least associate degrees." The EDI has already customized programs for the Intel and National Semiconductor Corporations, which has meant designing objectives and curricula around actual company data, processes, and culture. Each corporation has about 60 people enrolled in accelerated programs designed to cover material 50 percent faster than a standard program (12 weeks of material in 8 weeks). In order to partially offset industry costs (read subsidize), the state does not allow the full instructor "loading" (reimbursement per student). As a result, faculty are reluctant to add to their work load for a reduced income.

The competencies these two local giants want and invest in, interestingly, are broad based SCANS-type (communications, critical thinking, etc.) skills, not job-specific technical skills. But at the same time, educators who work closely with businesses say that production managers and smaller firms prefer employees with specific skills and industry experience. This reflects a perplexing dilemma in the Valley: how to reconcile the differences in skill and competency demands of large and small companies, of corporate executives and plant managers.

IV. The Scope of the Full Education and Training Establishment

In the electronics and computer industries, lifelong learning is a necessity, not just a goal. Therefore, virtually all technical employees rely not just on community colleges but on private non-profit and for-profit colleges, university extension programs, consultants, and other federal and state programs to continually upgrade their skills and knowledge. The education and training enterprise in Silicon Valley that takes on this task is a complex and often confounding conglomeration of complementary and competing institutions and businesses. The vast array of possibilities often confuse both the company seeking training services and the individual wanting an education. Fifteen different organizations offer an education program called "electronics technicians," nine offer one called "computer management information systems." One-stop shops are trying to help rationalize the system for individuals and organizations, such as Joint Venture which tries to unscramble the system for businesses.

Community colleges not only compete with each other, but also with a host of other private schools and training organizations for students and revenues. For example, the local private industry council (PIC) lists four public community colleges in addition to seven other organizations with education or training programs in electronics (see Tables 2, 3). Therefore, the colleges have to follow the lead of the industry by acting entrepreneurial and aggressively identifying a niche and capturing a share of the market.

Table 2
Electronics Pre-Baccalaureate Education and Training in Santa Clara County

Institution	Type	Program	Outcome
Mission Comm College	Public	Electronics technology	Certificate, A.S.
San Jose City Comm College	Public	Electronics: microwave	Certificate, A.S.
San Jose City Comm College	Public	Electronics techn. Associate	Certificate, A.S.
San Jose City Comm College	Public	Electronics technicians	Certificate
Foothill Comm College	Public	Microprocessor technology	Certificate, A.S.
Evergreen Comm College	Public	Electronics technicians	Certificate
Phillips Junior College	Private	Electronics technology	A.S.

Micro-Polytechnic Institute	Private	Electronics system tech	Certificate
Heald Inst. of Technology	Private	Electronics technician	A.S.
ITT Technical Institute	Private	Electronic engineering	A.S.
Center for Employ. Training	Private	Electronic assembly	Skills certificate
Inst. for Career Development	Private	Electronic technician	Diploma
Central Cty. Occup. Center	ROP[1]	Electrical maintenance technician	Skills certificate

[1] Regional Occupational Centers are part of the public secondary vocational system.

Source: *Santa Clara Training Directory 1996*, NOVA Private Industry Council, Sunnyvale, California, December 1996.

Table 3
Computer Related Programs Available Within Silicon Valley

Program	Number of programs	Number of Places Offering Them
Computer - General	9	9
Computer-Management Info. Systems	13	9
Computer Networking	8	6
Computer Programming	15	8
Software Applications	6	6
Computer Repair	5	5

NOVA Private Industry Council

In Sunnyvale, the Private Industry Council (NOVA) plays a pivotal role in the complex work force development infrastructure. While charged with implementing the Jobs Training Partnership Program, which targets disadvantaged workers, it uses

its position of neutral coordinator and information source to provide industry and individuals with critical intelligence to make informed choices. It planned and created "CONNECT! Workforce & Business Solutions for Silicon Valley," a one-stop shop that represents a coalition of 20 organizations collectively marketing their labor market information, placement services, customized training, research, expertise, and solutions to problems throughout the region. The 20 members actually represent many more than 20 organizations, since most members are coalitions themselves—for example, the two community college districts include four different colleges. NOVA served about 7,000 people in 1996, sending 2,000 students to training programs (between 600 and 700 to community colleges, others to private schools), and 5,000 directly to on-the-job training with employers.

The PIC also gathers and disseminates vital information about the region. Under a grant from the state, NOVA was asked to study 25 key occupations. Its director, however, did not believe that "occupations were the same across industries." Therefore, he chose to examine families of jobs that support specific industries. NOVA produced, for example, cluster specific workforce studies, such as "Circuits from Sand: Semiconductor Manufacturing Workforce Observations" (April 1996) and "Telecommunications Industry: Bay Area Labor Market Analysis" (1996). Another NOVA study focused on an industry rapidly sprouting out of the region's electronics base—bioscience. Students enrolling in this new program, which was reengineered from elements imbedded in many other programs, all got jobs.

WorkForce Silicon Valley

This organization is a response by the Santa Clara Valley Manufacturing Group (SCVMG) to the dilemma of skill shortages in the midst of an undereducated, often immigrant, labor pool. Even though the region is known for its technology, 53 percent of Silicon Valley youth do not go on to any type of postsecondary education, and 40 percent of those who do, drop out during the first year. According to the region's industry leaders, "without technical knowledge, relevant experience, and the applied skills needed to succeed in the global economy, the vast majority of these young people are destined for a low-skill, low-wage future, and our employers will look elsewhere for a high-skill workforce."

In 1995, the SCVMG established, and some of its larger members funded, "Workforce Silicon Valley" (WFSV). It immediately sought and received additional funding from the federal 1992 School-to-Work Opportunities Act to help reform the

K-12 school system, which carried much of the blame for the low attainment rates. WFSV organized its efforts around six learning collaboratives defined by industry clusters: Information Systems, Multimedia, Financial Services, Apparel Technology, Health/Biosciences, and Advanced Manufacturing.

These learning collaboratives, each of which includes representatives of high schools, community colleges, and industry, work with schools to meet standards established by WFSV (e.g., getting and using private sector input and active advisory boards; giving credit for work-based learning, with 80 percent of all students having 320 hours of work-based learning prior to graduation; providing individual mentoring; establishing four-year education plans for each student; articulating high school programs with technical programs in the community colleges; and creating small-scale school-within-school environments to build relationships between students and teachers). The collaboratives conduct faculty leadership institutes and staff development seminars, distribute "best practices," work to integrate SCANS competencies into the technician's curricula, and integrate career (cluster-based) learning into programs.

Notably, the region's largest employer cluster, electronics, was not designated as one of the six learning collaboratives. However, this is semantics, not oversight. The "Advanced Manufacturing" collaborative in Silicon Valley is defined by that industry, which is overwhelmingly electronics, and the program being devised is in fact electronics. It is based on the associate of applied science degree curriculum developed by Sematech in 1993 for semiconductor technicians and is tailored to the area's largest semiconductor manufacturer, Intel. This learning collaborative includes five local high schools, the Regional Occupational Program, Mission and San Jose Community Colleges (where Intel has established semiconductor technician programs), and Intel Corporation. It meets monthly to, among other things, identify new skill needs and develop standards (that are compatible with the national standards developed by the American Electronics Association), suggest improvements in curricula, and devise and find work site placements for students. In 1996, the collaborative offered college and high school faculty internships at Intel, and in the summer of 1997 added eight student internships.

Increasing skill requirements are one of the causes of the current skills shortage within the semiconductor cluster, which has raised the stakes for the Advanced Manufacturing Learning Collaborative. Intel is considering making an associate's degree a requirement for its technicians, and insists that the programs include a heavy dose of math and physics. To emphasize this commitment, the company has agreed not to raid programs for employees before graduation. But the company will recruit technicians early, offering them tuition reimbursements to complete their program. One of the limitations still to be overcome is that Intel is viewed as the dominant

player and primary beneficiary. The company is trying to reduce its dominance and encourage other companies, including SMEs, to become invested and active in the collaborative—a major challenge if it is to become a cluster-wide effort and not a massive customized program.

V. Wired into the Cluster

The effectiveness of the De Anza and Mission Community Colleges' electronic initiatives is closely related to the colleges' ability to collaborate with and network themselves into the members of the clusters and its array of specialized services. Colleges have to be creative and innovative when engaging in activities that have not traditionally been considered education policies. Since colleges are by definition public institutions serving the public good by educating individuals, and because business and labor have no institutionalized roles or lines of authority within U.S. colleges, business connections are most often informal.

Business, industry, and their associations

De Anza Community College is dependent on business support, according to its Dean of Instruction. "The cluster provides the colleges with the best teachers, grants to purchase equipment, and internships for students. It sets the tone for where we go and what we do." There is also an informal cultivation of relationships with industry leaders through CEO breakfasts and an annual "Night of Magic" which honors CEOs. The college's manufacturing programs facilitate user's groups for ProEngineer and AutoCAD, bringing industry users together with the software experts to solve common problems. This sometimes leads to more intensive and continuing mini-networks among users. The small group of companies that specialize in model building are also tightly networked with the college.

The CACT also has links with industry that concentrate on smaller companies. It has its own advisory board comprised of members from industry, which meets semiannually but also is called upon by staff as needed. The CACT works with industry and professional associations, such as the Institute for Electrical and Electronic Engineers, which has 40,000 members in the area, and both the Association for Quality and APICS advertise and promote workshops for CATC.

Mission Community College has also been very successful in building partnerships, particularly with the semiconductor industry, which resulted in a new associate degree program. On the one hand, the connections to the industry have brought new students and revenues to the college, and on the other they have produced a steady stream of well-trained technicians for the rapidly growing industry.

VI. Impacts on the Cluster

Although the electronics, computer, and software companies in Silicon Valley function as a classic cluster, the rapid diffusion of technology, information, and knowledge through social networks is much more prevalent among the professionals and managers than among the work force. Because the technology used and produced by the cluster is advancing so quickly, and because the work force is so mobile and includes so many recent immigrants, detailed knowledge of the industry has not had time to be fully absorbed into the non-business culture. This is not an industry that is family-oriented and is not as likely to be the topic of discussion at social outings or family picnics as it is, for example, among furniture employees in Mississippi. Despite the heavy industry concentration, many young people, *Workforce Silicon Valley* has discovered, have little understanding of what work is really like within the industry. Therefore, the community colleges have a more difficult time attracting students into the program and they must become more effective at marketing the industry and its opportunities.

Opportunities for Students

The electronics-based cluster dominates the employment base of the region. Many other employers are either suppliers, spin-offs, or consumers of the industry. Students who acquire skills in electronics and computer systems will have little trouble finding work, given the shortage of skilled workers in the industry and projections for continued growth. Analysts predict a need for 120 new eight-inch wafer fabrication facilities in the next few years.[6] Right now, student have little trouble finding jobs after—and sometimes before—graduation. Colleges' employment offices are available but underutilized (i.e., not needed) by students, most of whom are already in the labor market and linked through the many social networks that serve as efficient sources of job opportunities.

One reason that some students opt for employment before graduation is that the two-year associate degree is not yet a required or important credential in the eyes of most employers. But there is growing evidence (mainly from the largest companies and supported by Sematech's newest skill standards) that the status of the associate degree is changing, and that it may soon become as essential an employment requirement as a high school diploma has been in the past—but that day has not yet arrived. What <u>is</u> important to employers are the skills and experience that students acquire in the community colleges. In fact, a large number of enrolled students already have their baccalaureate degrees and do not need another, less marketable, credential. Instead, they enroll to specifically acquire the new and more marketable skills that community

colleges teach in a more affordable, more practical, and more accessible manner than the universities. The rapid pace of change within the industry demands frequent skill upgrading and retraining, which the community colleges are more adept at doing than most other institutions within the region, public or private.

Impacts on Businesses

The largest electronics employers make effective use of the resources of the two community colleges, De Anza and Mission. As the workplace requires greater depth of scientific and general knowledge, public colleges become more attractive to businesses than the more narrowly focused private technical schools. Although De Anza's CATC targets SMEs, for the most part, the primary beneficiaries of the colleges' programs are the largest companies. Yet due to the high labor market turnover among workers, SMEs can benefit if they are able to attract skilled workers from the larger firms. The giant corporations, which are able to invest in and acquire state support for training, build an experienced core labor force that many firms draw upon. For example, although Intel is Mission's partner in the Semiconductor Manufacturing Technician programs, they only expect to eventually employ 25-30 percent of the completers. Community colleges also are major sources of management training and technical assistance for the smaller companies that are less able to afford the numerous consultants in the area. Non-credit college-based programs such as the Center for Applied Competitive Technologies or the Small Business Development Centers provide low-cost expertise and services.

Effects on the Region's Economy

Workforce issues are considered among the region's highest priorities and perhaps its major barrier to growth. The Santa Clara Valley Manufacturers' Group has named as the most three critical issues facing the region housing, transportation, and workforce development. "Employers report it is difficult finding applicants [electronic and electronic engineering technicians]," it reports, "who are both fully qualified and experienced as well as qualified but inexperienced."[7] Hence, the formation of Workforce Silicon Valley and increased emphasis on postsecondary technical education. In addition, the degree to which the colleges specialize in the business of the cluster is a major consideration in rating the competitive advantage of the cluster. Without such a specialized labor force, electronics would exist as a cluster, but it would certainly lose much of its luster. Further, the advantage the region now holds for retaining so much of the cluster's production would be diminished.

Challenges Down the Road

According to Mission Community College's president, the major challenge for the college is similar to that facing the region itself—dealing with the unavoidable cyclical nature of high-tech industries. As young industries mature, manufacturers tend to seek out lower cost regions for production, and the region must continually modernize its production capabilities and reinvent itself to find new products and markets. Joint Venture: Silicon Valley was created for that purpose. The colleges must not only keep up with these changes, but also have the vision to foresee the emerging skills and knowledge that will be needed in the future if the work force is to have the flexibility and knowledge base to adapt.

Another issue is the intense competition among the numerous organizations that provide education or training. This forces the community colleges to stay on top of technological changes, identify niches where they can excel, and stay close to the customers. Like the businesses, the successful schools will be those able to follow the path of the cluster and reinvent themselves along with the cluster.

Attracting good students into manufacturing is a growing problem that mirrors societal trends in attitudes towards white collar and professional occupations. A persistent negative image of the blue collar machinist of the 1950s is still a barrier to youth choosing manufacturing as a career. Even though much of the manufacturing in Silicon Valley actually is carried out in white coats and clean rooms, it still lacks the prestige of office-based occupations. One result of these trends is that technical programs are forced to recruit and are attracting students from lower income families with poorer educational foundations and lower achievement levels. The skills of entering students, according to administrators, have noticeably declined.

Finally, multi-culturalism is an issue given that immigration rates are high in the region, and for large segments of its population, English is a second language. This requires special attention to language and cultural differences and raises the costs of technical education.

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[1] Mike Marando, "California's Counties Have a Stake in Developing State's New Economy," *California County Magazine*, September 1997.

[2] Bryan Monroe, "SJCC unveils virtual teaching lab,: *San Jose Mercury News*, September 26, 1997, p. B1.

[3] See Henry Levin and Russell W. Rumbarger, "High-Tech Requires Few Brains," *Washington Post*, (January 30, 1984) and Harley Shaiken, "The Automated Factory: The View from the Factory Foor," *Technology Review*, 88 (January 1985).

[4] Joint Venture*, Index of silicon valley: Measuring progress toward a 21st century community* (San Jose: Joint Venture: Silicon Valley Network, 1997).

[5] The Resource Group, *Business Today/Business Tomorrow: A Report of the Northern Sanata Clara Business Retention and Economic Development Project*, Foothill-De Anza Community College District, Cupertino, California, 1996.

[6] NOVA, *Circuits From Sand: The Semiconductor Manufacturiung Industry Research Project* (Sunnyvale: NOVA Private Industry Council, 1996), p. 9.

[7] NOVA Private Industry Council, *Santa Clara County Training Directory*, (Sunnyvale: California Employment Develpoment Department and Occupational Information Coordinating Committee, December 1996, p. 4-7.